Notre Dame Bridge
Spanning the Merrimack River on Bridge Street
Manchester
Hillsborough County
New Hampshire

HAER No. NH-14

HAER
NH,
6-MANCH,
12-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Mid-Atlantic Regional Office
National Park Service
U.S. Department of the Interior
Philadelphia, Pennsylvania 19106

HAER
NH,
6-MANCH,
1-

HISTORIC AMERICAN ENCINEERINC RECORD

Notre Dame Bridge

HAER No. NH-14

Location:	Spanning the Merrimack River on Bridge Street, connecting the east and west portions of the city of Manchester, Hillsborough County, New Hampshire UTM: Zone 19 Easting 298640 Northing 4762890 Quad: Manchester South
Date of Construction:	1936-1937
Engineer/Builder:	J. R. Worcester Company, Boston, Massachuseyys
Present Owner:	City of Manchester, New Hampshire
Present Use:	Vehicular Bridge
Significance:	The Notre Dame Bridge is significant as the best example of the steel arch truss (the most advanced metal truss design) in New Hampshire. The structure is one of five surviving steel arch bridges in the State. The steel arch is 444 feet in length; together with its 12 concrete approach spans, it is the longest bridge of the pre-war era in New Hampshire. The Notre Dame Bridge is associated with the redevelopment of the historically significant, bankrupted (1936) Amoskeag mills, and provided continuation of the vital transportation link between the manufacturing district and the densely-populated Franco-American community of Manchester's West Side. Known as the Notre Dame section of the city, this intensely ethnic settlement housed French Canadian emigrants who provided the bulk of the labor force for Manchester's cotton textile industry during the late 19th and early 20th centuries. Built as a New Deal project during the Creat Depression, the Notre Dame Bridge was one of the largest public works projects undertaken in New Hampshire, and is the only steel arch spanning the Merrimack River.
Project Information:	This documentation was undertaken in March/April 1988 as a mitigative measure prior to the planned demolition of the Notre Dame Bridge, and its replacement with a new, two-lane high level span, scheduled for completion in 1990. Bridge Replacement Project No. M-5285(001), C-2330. Prepared by Christopher W. Closs, Closs Planners, Inc., Concord, NH, for the New Hampshire Department of Transportation, Concord, NH.

I. SITE FEATURES AND HISTORICAL BACKGROUND

The Notre Dame Bridge, spanning one of New England's great rivers, the Merrimack, is located within the urban core of Manchester, New Hampshire, the State's largest city. The bridge links the city's business and manufacturing center with the predominantly residential, ethnically homogenous area known as the Notre Dam section of the city's West Side. Manchester, 56 miles north of Boston, is situated in the Merrimack River Valley, which drains an area of 2,632 square miles and extends from the river's headwaters at Lake Winnipesaukee to the sea at Newburyport, Massachusetts, a distance of 130 miles. The Merrimack River served as a highway for early settlers migrating northward from Connecticut and Massachusetts during the eighteenth century. Derryfield, as Manchester was originally known, was established in 1751 on the east side of the river, below the Amoskeag Falls. During the nineteenth century, it was the vast water-power of the Merrimack, coupled with new technology, which spawned the great textile manufacturing cities of Lowell, Manchester, Lawrence, and Nashua. In Manchester, the cotton mills of the Amoskeag Manufacturing Company (1828-1937), lining both sides of the Merrimack below the falls, have created a permanent industrial environment.

The Notre Dame Bridge is one of four crossings of the Merrimack River within the city proper. A fifth, non-historic span is located south of the city along Interstate 293 and connects with the Town of Bedford. The bridge is located within the river's flood plain approximaely half a mile south of Amoskeag Falls, at elevations ranging from 150 feet on the west side to 200 feet (above sea level) at the eastern end. The distance across the Merrimack River is approximately 415 feet at this point.

The river channel is defined, along the eastern bank, with a granite retaining wall running for more than a mile, framed against the continuous background of the red brick mill buildings. Two successive pairs of granite piers rise from the river downstream from the bridge, remnants of utility bridges which once linked the mills. The west bank of the river remains in its natural state, a sloping gravel bank. Stream depth is approximately 17 feet beneath the bridge. Water level has been controlled by a series of flood control dams erected by the U.S. Corps of Engineers, following the floods of 1936 and 1938.

The site of the crossing of the Notre Dame Bridge is significant as the location of the first bridge erected across the Merrimack River in New Hampshire. In 1792, on a site approximately 100 feet north of the present bridge, Colonel Robert McGregor financed and built a wooden toll bridge to link Goffstown with Derryfield. This bridge was known as the (first) Amoskeag Bridge. McGregor, former aide-de-camp to General John Stark during the Revolutionary War, resided and operated a tavern at the west end of the bridge. The tavern was located at the present intersection of North Main, Amory and McGregor streets, on the Boston-Concord Road. The village of McGregorville grew up around this site.

By 1815, the original bridge was impassable and soon fell to ruin. In 1825, Colonel William P. Riddle erected the second bridge at a cost of $3,600. In 1838, the Amoskeag Manufacturing Company purchased the bridge and immediately abolished the toll for foot passengers. In 1848, the bridge was damaged by flood, having two piers swept away in a freshet. These were replaced and the bridge continued in service until 1851, when the entire structure was carried away by flood.

For thirty years, the Old Amoskeag Bridge, as the structure became known, was not replaced. As Manchester developed, propelled by the success of the Amoskeag and Stark mills, so did the city's transportation system expand. Two other bridges, the Amoskeag Falls covered bridge, upstream, and the span at Granite Street, downstream, were built to connect the manufacturing district with the homes and tenements rapidly rising in McGregorville and Piscataquog, villages on the west bank of the river, where land was still plentiful and inexpensive.

In 1880, following heated public debate over cost, the new McGregor Bridge was begun. The city of Manchester, with $7,000 in contributions from the Amoskeag and Stark mills corporations, contracted with the Corrugated Metal Company of East Berlin, Connecticut, to build the new structure at an unprecedented cost of $67,000. Consisting of three spans with two piers and abutments of cut granite, the new bridge had two decks - the upper level for general vehicular travel and the lower reserved by the corporations for mill employees traveling to and from work. The 930-foot bridge, which was 40' wide, used the Douglas patent parabolic arch truss design (1877), which was widely popularized by the builder's successor company, the Berlin Iron Bridge Company.

The span opened on August 10, 1881, and was officially named McGregor Bridge, in honor of Colonel Robert McGregor and his contributions to the nation and community. McGregor Bridge continued in service until the great flood of March 20, 1936, when two spans were torn away by record high water levels. The same flood also gutted the bankrupted Amoskeag mills, which had closed previously, precluding any possibility that the company would reopen following reorganization.

By 1934, the McGregor Bridge, originally designed for carriages and wagons, had proven inadequate for the increase in motor vehicle traffic loads. Separation of the railroad grade crossing had also become a safety issue. In 1934, the Manchester Board of Alderman considered and defeated a resolution for a new, high-level bridge. In 1935, the resolution was passed, only to be disapproved by the Finance Commission.

Planning for replacement of the McGregor Bridge began immediately after the March 1936 flood. J. R. Worcester Company, Engineers, of Boston, Massachusetts, were retained to design the new structure. Drawings were completed in September and October of 1936 and construction began on the concrete causeway in October of the same year. The new bridge, called the Notre Dame Bridge, was officially opened to foot traffic on December 9, 1937. The formal opening, with Mayor Damase Caron presiding over the ribbon-cutting ceremony, was held on December 31, 1937, when the bridge was opened to vehicular traffic. The approach ramps at the east end connecting with Canal Street were not completed until spring of 1938.

Controversial public debate took place during the fall of 1937 concerning the name of the new bridge. Three names were proposed - Robert McGregor, Veterans Memorial, and Notre Dame - the latter honoring the Franco-American community which had, by the 1920s, densely settled in the lower west side of McGregorville around Ste. Marie's Church, near Notre Dame Hospital. Without a formal public hearing on the matter, Mayor Caron and the Board of Alderman resolved, on November 9, to name the new structure Notre Dame Bridge.

Construction of the Notre Dame Bridge provided a vital link in the revival of the economic health of the city in the decades which followed. In 1937, Amoskeag Industries, Inc., was formed by local businesses and banks to preclude the auction and dispersal of the property of the Amoskeag Manufacturing Company. Under the new organization, many new industries were attracted to Manchester, helping to diversify the city's economic base. As one of four bridges linking the residential west side with the employment center of industry and retail trade on the east side, the Notre Dame Bridge has served as an integral part of the urban transportation infrastructure. The only steel arch bridge erected in Manchester, Notre Dame Bridge achieved landmark status by its prominent location and distinct appearance. The significance of the bridge was recognized in January 1988, when it was determined eligible for listing in the National Register of Historic Places.

II BRIDGE DESCRIPTION

The Notre Dame Bridge is a 1,459' 6" structure composed of a causeway with eleven concrete arch rib spans, one rigid frame steel span encased in concrete, and a 444' two-hinged parabolic steel arch truss which spans the Merrimack River.

The bridge spans the Everett Turnpike, the Merrimack River, the millyard of the former Stark Mills, the Boston & Maine Railroad tracks, and Canal Street. It originally passed over the upper and lower canals as well, which flowed south between Canal and Commercial streets before the waterways were filled in during the 1970s.

Oriented on an east-west axis, Notre Dame Bridge provides the connection between Route 114, west of the city, and Route 101 and Massabesic Lake to the east.

The bridge consists of one travel lane in each direction and sidewalks on both sides, for a total width of 42 feet.

Access to the bridge from the west is by way of Amory Street or McGregor Street at a signalized intersection with traffic islands. On the east side of the river, existing one-way streets serve as ramp connections between Canal Street and the Notre Dame Bridge. Westbound access from Canal Street to the bridge is by way of Kidder Street and Charles Street which connects with Bridge Street. Eastbound access from the bridge to Canal Street is by way of Charles Street which intersects with Bridge Street, and then to Acme Street which connects with Canal Street. Figure 1-1, on page 15, shows a 1937 plan view of the original scheme at the east end.

The most visually prominent feature of the Notre Dame Bridge is the steel arch truss which spans the Merrimack River. Overall views and details of this structure and the causeway may be found in the 27 photographs which accompany this text. Exhibit 1, New Hampshire Department of Transportation Bridge Inventory Card, on page 16, summarizes pertinent design data and dimensions of all of the spans. Copies of the original engineering drawings (a total of 30) may be found with the photographs.

Causeway

The causeway consists of eleven reinforced concrete arch rib spans which vary in length but are identical in design and detail. On the east side of the river, there are nine such spans; seven of these are 90′0" in length and two are 64′ 3". On the west side of the river, there are only two spans and these are both 64′ 3" in length. Overall, outside-to-outside dimension is 44′ 0"; travel lanes are each 15′ 0" and sidewalks 6′ 0".

Each span consists of four tapered reinforced concrete parabolic arch ribs spaced 13′ 8" on center, whose thrust is carried by massive pylons of the same material. The ribs are given lateral strength by means of perpendicular, integral arched floor beams, the number of which vary with the differing length of the spans, but which are spaced from 6′ 8" to 9′ 0" on center. The deck and sidewalks consist of an integral 8" concrete slab; utility ducts were formed beneath the north sidewalk to carry electrical cables. The roadway wearing surface consisted originally of 2" asphalt, pre-mixed. The grade of the eastern portion of the causeway is 4.78 percent. The causeway was built with a H-15 load rating.

The exterior surfaces of each of the arch rib spans are expressed in the Art Deco architectural vocabulary, although restrained.. The massive pylons are shouldered and tapered, with the faces vertically incised to suggest the imagery of streamlined strength and speed, while the parabolic arches (designed to harmonize with the silhouetted lines of the steel arch) and the floor beams are expressed in the face of the concrete, subtly suggesting, at least, that form follows function.

The bridge railing consists of a continuous concrete balustrade, 3' 9" in height, which is interrupted only by expansion joints and the massive pylons. There are four niches, created between the pylons of the end abutments, which are provided with cast-in-place concrete benches, where pedestrians crossing the long bridge might rest.

Bridge lighting consists of contemporary sodium vapor "cobra-type" fixtures mounted on spun aluminum poles, mounted upon every other pylon. The original lighting scheme, now removed entirely, consisted of 32 luminaries carried on spun reinforced concrete poles, mounted on top of each pylon (see c. 1940s photographs, page 20).

Access from the elevated roadway deck to the street network below was provided by a single, two-story, exterior steel stair located on the north side of the causeway, between spans 4 and 5. The cantilevered stair, now altered by the relocation of the lower run inside of the pylon, is adorned with a wrought iron rail and forged lateral supports. The stair permitted pedestrians and workers at the Stark mills to descend directly to Canal Street from the limited access causeway, without having to walk to the east end.

Two bronze commemorative plaques were originally fastened to the inside of the concrete rail at the west end, near the portal of the steel arch span. These are missing and the information they carried is unknown.

Rigid Frame Span/Causeway

The second span at the eastern end of the causeway is a steel, plate girder rigid frame bridge, measuring 94' 6" overall, which originally spanned Canal Street and the railroad tracks of the Boston & Maine's Southern Division. The tracks were relocated during the 1970s, to the adjacent span (span 3). Span 3 previously crossed the Upper Canal; this channel was filled, along with the Lower Canal, which flowed beneath Span 6, during the same period. Canal Street, which paralleled the tracks, was also widened for four lanes of traffic.

Designed to eliminate the railroad grade crossing with Bridge Street, the steel rigid frame span (span 2) is distinct in design technology and appearance from the flanking concrete and rib structures of the causeway. The seven plate girders which form the rigid frame have a very low, segmented arch form, in contrast to the more expressive parabolic arches of the adjacent spans. Pylon and railing details, however, are identical to the typical designs of the causway, as described above.

Built to accommodate Canal Street and the B & M's double track, the rigid frame design offered greater lateral clearance (80' 0") than the arch rib design, and superior vertical appearance (18' 9") at the extremities of the span.

The seven riveted steel girders are entirely encased in concrete (Gunite) to provide additional weather protection and to afford a uniform appearance for the twelve spans of the causeway. The two outside girders are 1' 0" deeper than their interior counterparts. Cast iron blast plates, designed to protect the flanges of the ribs from corrosive locomotive exhaust, are bolted in place above the (former) railroad tracks, beneath the west end of the span.

The roadway deck consists of 6-1/2" reinforced concrete slab, topped with 2" of asphalt for the wearing surface. Bridge camber is 2-9/16". Sidewalks, railings, and lighting are identical to those found on the arch rib spans. The railings have only one expansion joint, at the center.

Architectural detail is expressed simply, with the segmental arch, floor beam ends, and deck all cast in relief in the concrete finish.

The causeway is constructed entirely of reinforced concrete, with expansion joints at each pylon. Concrete surfaces have aggregate partially exposed. Drainage is accomplished by means of 6" leader pipes inside each pylon, which collect runoff from the roadway deck at the open expansion joints.

<u>Steel Arch Truss</u>

The steel arch which spans the Merrimack River is of the Pratt truss type. It has two hinges and riveted construction. The river is aligned with a 12-degree skew at this point. The steel arch falls between spans 10 and 11 in the 1,459' 6" overall length of the causeway and approaches.

The overall length of the steel arch is 444', spanning a channel width of 415'. The bridge area opening is 21,500'±, while the concrete arch rib spans of the causeway serve as relief openings, giving an ample margin of flood safety. Like the causeway, the steel arch was designed for H-15 loads and maximum protection from flooding. The roadway deck is built 52' above normal water level and 20' above the record high water level experienced in March 1936. The crown of the arch is 130' above the river.

The parabolic steel arch consists of 28 panels, each 15' 8" in length. The four hinge pins are 8" in diameter and secured with a hexagonal nut. The two arch crown pins are 6" in diameter and secured similarly. The hinge bearings are seated in two massive reinforced concrete piers. The depth of the truss web ranges from 23' 0" at the springline to 10' 0" at the crown. The two arch trusses are typically connected and braced with two cross frames composed of x-members, and top bracing consisting of v-members, all built with riveted steel channels and angles. The bottom chords are each braces with a singlw x-member, below the two end panels. Here, extra vertical and horizontal struts (I-beams) are added for increased stability at the bearings.

The chords are built up using channels connected by solid plates and double lattice. Channels are both reinforced and lapjointed with fish plates in the web. Solid steel plate is used for the top of the upper chord. For the lower chord, the design is the same, except double lattice bars and solid plate are used for the top and bottom surfaces of the member.

The bridge floor is suspended from the arch on solid steel hangers (I-beams), typically connected to the lower chords by 2-3/4" pins. The bridge floor beams are fastened to the hangers with 1-1/2" U-bolts and 3" pins.

The bridge portals, located at the second panel, are distinguished by overhead steel lattic cross frames, which allow 14' 0" clearance from the deck. The roadway width is 30' 0". The portals are further articulated with end post bracings, which employ v-members of channel and lattice.

The floor system consists of 30" deep steel beams suspended perpendicular to the arch, set at 15' 8" on center. The outside-to-outside dimension of the floor system is 52' 4". Two 6' 0" cantilevered sidewalks are carried on shorter beams superimposed on top of the main members. A gas main was originally carried outboard of the sidewalk on the north elevation, while a municipal water main ran along the south side. Lighting conduit ran in a cluster beneath both sidewalks.

The floor beams support six 16" roadway stringers within each panel. Irving decking, 2-1/2" open steel grating, is used for the deck and wearing surface and was originally employed for the sidewalks. This has been replaced with treated wood plank flooring. Drainage is through the deck.

The sidewalk railings are of the post and rail type, with round balusters. Constructed of steel pipe, the 3' 8" assembly is bolted directly to the short sidewalk beams. Each section is 7' 10" in length. A 6' chain link, anti-suicide fence has been added inside the original railings for additional public safety.

The original lighting for the steel arch was supported on four overhead steel struts fastened perpendicular to the roadway. This system is no longer used and the fixtures have been removed. Eight typical sodium vappr "cobra-type" fixtures are currently mounted on the hangers, spaced equidistantly on both sides above the deck.

All steelwork is painted light green. Only one (of four) manufacturer's plaque survives. This is located at the west portal, bolted to the top plate of the upper chord of the south arch truss. The plate is cast iron and carries, in relief, the following information:

American Bridge
Company

U.S.A. 1937

Steel hangers and numerous other members bear the manufacturer's name "Carnegie U.S.A." in relief.

III. DESIGN AND CONSTRUCTION

The Notre Dame Bridge was designed in 1936 by J. R. Worcester & Company of Boston, Massachusetts, noted engineers of steel and reinforced structures. The firm's founder and principal, Joseph R. Worcester of Waltham, Massachusetts (1860-1943) was one of the country's foremost engineers in the design of steel structures and foundations. Worcester designed most of the steel framework for the Boston Elevated Railway, the steelwork of the Boston subway, and the viaduct across the Charles River Dam. In 1921, Worcester was appointed by President Herbert Hoover, then Secretary of Commerce, to serve on a committee to formulate building codes and materials standards. An 1882 graduate of Harvard College, J. R. Worcester was long associated with the Boston Bridge Works, serving first as a draftsman and later as the firm's engineer. In 1907, he organized the firm of J. R. Worcester & Co., retiring in 1924. He worked as an engineering consultant until his death on May 10, 1943.[1]

Worcester designed the first steel arch bridge to span the Connecticut River, at North Walpole, New Hampshire, to Bellows Falls, Vermont, in 1905. For a time, this structure was the longest steel arch built in the United States. In 1928, the firm also designed the steel arch crossing the Connecticut River at Haverhill, New Hampshire. There are 18 extant bridges known to have been designed by the J. R. Worcester firm currently listed in the Massachusetts Department of Public Works data base and several in New Hampshire.[2]

Copies of the original drawings, which accompany this text, are unstamped and do not bear the name or initials of the project engineer for the Notre Dame Bridge. It is known that Thomas Worcester, son of Joseph R. Worcester and a member of the firm, and Charles R. Turner, resident engineer, were associated with the project.[3]

The steel arch truss design and "high-level" causeway were chosen for the Notre Dame Bridge based on site constraints, flood hazard, and bridge technology and cost. Changing transportation needs and traffic circulation patterns also influenced the overall length of the bridge.

The Bridge Street site for crossing of the Merrimack River had been recognized as an advantageous location by Robert McCregor in 1792. The opposite banks of the river are roughly the same elevation at this point, allowing a relatively level bridge to be constructed. By 1936, the Bridge Street corridor was well established at the present location.

The second factor which influenced the bridge design was the necessity to eliminate future flood damage to the new structure. The steel arch, whose maximum design potential was 1000', was ideally suited to create a clear span over the river and above record floodwater levels. Although the steel arch, whose application is most economically suited to ravines or deep rock gorges where natural abutments of ledge exist, did not lend itself to this design problem alone, the development of the high-level causeway concept made this solution feasible.

Impetus for the cauaeway concept came from the increasing use of motor vehicles as the common means of private transportation - and the need to eliminate canal and railroad grade crossings while improving traffic flow through the city.

By designing a high-level structure, the possibility of catastrophic loss by flooding was also decreased. Not only was the steel arch truss constructed 20' above record flood levels, but the concrete arch rib spans would allow destructive flood waters to pass through, rather than remove the man-made structure.

In 1938, a little more than a year after completion of the Notre Dame Bridge, the design was put to the test. During this flood, the massive, 55,000 gallon oil tanks located on the island below Amoskeag Falls broke loose and floated downstream. The tanks passed under the Notre Dame Bridge, only to batter the structure at Granite Street.

The J. R. Worcester Company prepared the engineering drawings for the project between July and October of 1936. The bridge was to be built under four separate contracts. These were let by the city of Manchester as follows:

Contract No. 1	J. R. Fitzgerald Company, Boston, Massachusetts
Contract No. 2	Arute Brothers, ..., Connecticut
Contract No. 3	J. F. Fitzgerald Company, Boston, Massachusetts
Contract No. 4	American Bridge Company, Ambridge, Pennsylvania

Work began with the concrete footings and piers for the arch rib spans, progressing through the winter of 1937.

Steel for the arch span began arriving on July 19, 1937, and was yarded on the west bank of the river, beneath the two completed concrete arch rib spans. Four massive wooden piers on which to build the arch were erected in the river. On September 28, 1937, the completed steel arch truss, which had been constructed from both abutments and finally joined at the center, was "jacked down," loading the arches under the compression of their own dead load. Work commenced on installation of the hangers and floor system. Use of Irving decking, which was applied in sheets 37' long and 28' wide and welded together, was the first example of this material used on a bridge in New Hampshire.[4]

During the construction period, a temporary cable suspension bridge was built about 100' upstream, for use of pedestrians and factory workers. Construction of the east approach, between Canal and Commercial streets, required removal of the 60-ton, 155' wooden lattice overpass connecting the Stark mills. The contract for removal of this structure was awarded to Davison Construction Company of Manchester, who lowered each truss to the ground and dismantled the heavy timber members.[5]

Each of the poured-in-place, concrete arch rib spans was constructed using plank forms, employing skilled carpenters. Materials used in the construction of the Notre Dame Bridge included 8,854,000 pounds of cement, 520 tons of steel reinforcement, and 1,000 tons of structural steel for the arch truss.[6]

The Boston Bridge Works, East Cambridge, Massachusetts, was involved in the design and erection of the 94' 6" steel rigid frame span crossing the railroad tracks.

Total costs for the Notre Dame Bridge were broken down as follows:

$250,000	City of Manchester
135,000	State of New Hampshire (state flood relief fund)
187,000	Works Progress Administration
160,000	Federal Bureau of Public Roads (grade crossing elimination)
$732,000	Project Total [7]

IV. FOOTNOTES

[1] New York Times, New York, NY, May 10, 1943. Obituary of Joseph R. Worcester.

[2] Roper, Steven J. Historic Bridge Specialist, Massachusetts Department of Public Works, Boston, Massachusetts. Interview with Christopher W. Closs (by telephone), March 16, 1988, regarding background on Joseph R. Worcester, his firm and the number of bridges in Massachusetts attributed to this engineer.

[3] Union Leader, Manchester, NH, December 10, 1937.

[4] Ibid. September 28, 1937; October 23, 1937.

[5] Ibid. July 30, 1937.

[6] Ibid. December 10, 1937.

[7] Ibid. December 10, 1937.

V. BIBLIOGRAPHY

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Correspondence between the New Hampshire State Historic Preservation Officer, R. Stuart Wallace and Carol Shull, Chief of Registration, National Register of Historic Places, dated December 21, 1987; and Determination of Eligibility Notification, National Register of Historic Places, National Park Service for Notre Dame Bridge, Merrimack River, Manchester, Hillsborough County, New Hampshire, dated January 7, 1988.

Darnell, Victor C. Directory of American Bridge-Building Companies 1840-1900. Washington, D.C.: Society for Industrial Archeology, 1984, pp. 85-86.

Manchester Public Library, Manchester, NH. Notre Dame Bridge vertical file. File consists of numerous dated and undated/unattributed newspaper clippings and photographs of McGregor Bridge and Notre Dame Bridge.

Manchester Public Library, Manchester, NH. Notre Dame Bridge vertical file located in the New Hampshire Room. File contains assorted newspaper clippings, mostly unattributed, from 1936-37 and 1985-1988.

Manchester Yesterday and Today. New England Advertising Associates, Inc. Manchester, NH: Lew A. Cummings Company, 1946, (unpaged).

Mirror and American, Manchester, NH, October 22, 1879, August 10, 1881.

Mock, Elizabeth B. The Architecture of Bridges. New York: Museum of Modern Art, 1949, p. 88.

"Manchester No. 122/072," New Hampshire Bridge Inventory Card Index. New Hampshire Department of Transportation, Bridge Division. Six cards. July 31, 1940.

New York Times, New York, NY, May 10, 1943.

Porter McGee Company. "Manchester: The Notre Dame Bridge." Le Canado Americaine. Vol. 12, No. 3. Summer 1986.

Sverdruf & Parcel and Associates, Inc. "New Hampshire Historic Bridge Inventory." 1982. Prepared for the New Hampshire Department of Public Works and Highways, the inventory consists of reports on 149 New Hampshire highway bridges. The Notre Dame Bridge was not included in the inventory in 1982. Since 1982, the New Hampshire Department of Transportation has implemented a Bridge Rating System and the Notre Dame Bridge has been included in the Steel Arch Truss (Summary Data). Filed with the New Hampshire Department of Transportation, Concord, NH.

Union Leader, Manchaster, NH, March 20, 1936 - December 31, 1937.

U. S. Department of Transportation, Federal Highway Administration. New Hampshire Department of Public Works and Highways. Final Environmental Impact Statement Section 4(f) Evaluation Notre Dame Bridge Replacement Manchester, N.H. Project No. M-5285 (001), C-2330. 1981, pp. 1-2, 1-3.

Maps and Historic Views

Location Plan Figure 1-1. Notre Dame Bridge Replacement. State of New Hampshire. Department of Public Works and Highways. Metropolitan Manchester Planning Study Area. 1981.

Map of the City of Manchester, NH. Manchester, NH. James E. Weston, C.E. 1870.

Sanborn Insurance Map, Manchester, NH. New York: Sanborn Map Company. 1954.

Bird's Eye View of Manchester, NH. Lithograph by C. H. Vogt. 1876.

Photograph of Bridge Street Bridge (McCregor Bridge) 1881-1936. Undated photograph in Notre Dame Bridge vertical file. Manchester Historic Association. Manchester, NH. (Photograph NH-14-1)

Newspaper photograph of Notre Dame Bridge, Manchester, New Hampshire. Undated/unattributed c. 1938. Notre Dame Bridge vertical file. Manchester Historic Association. Manchester, NH. (Photograph NH-14-2)

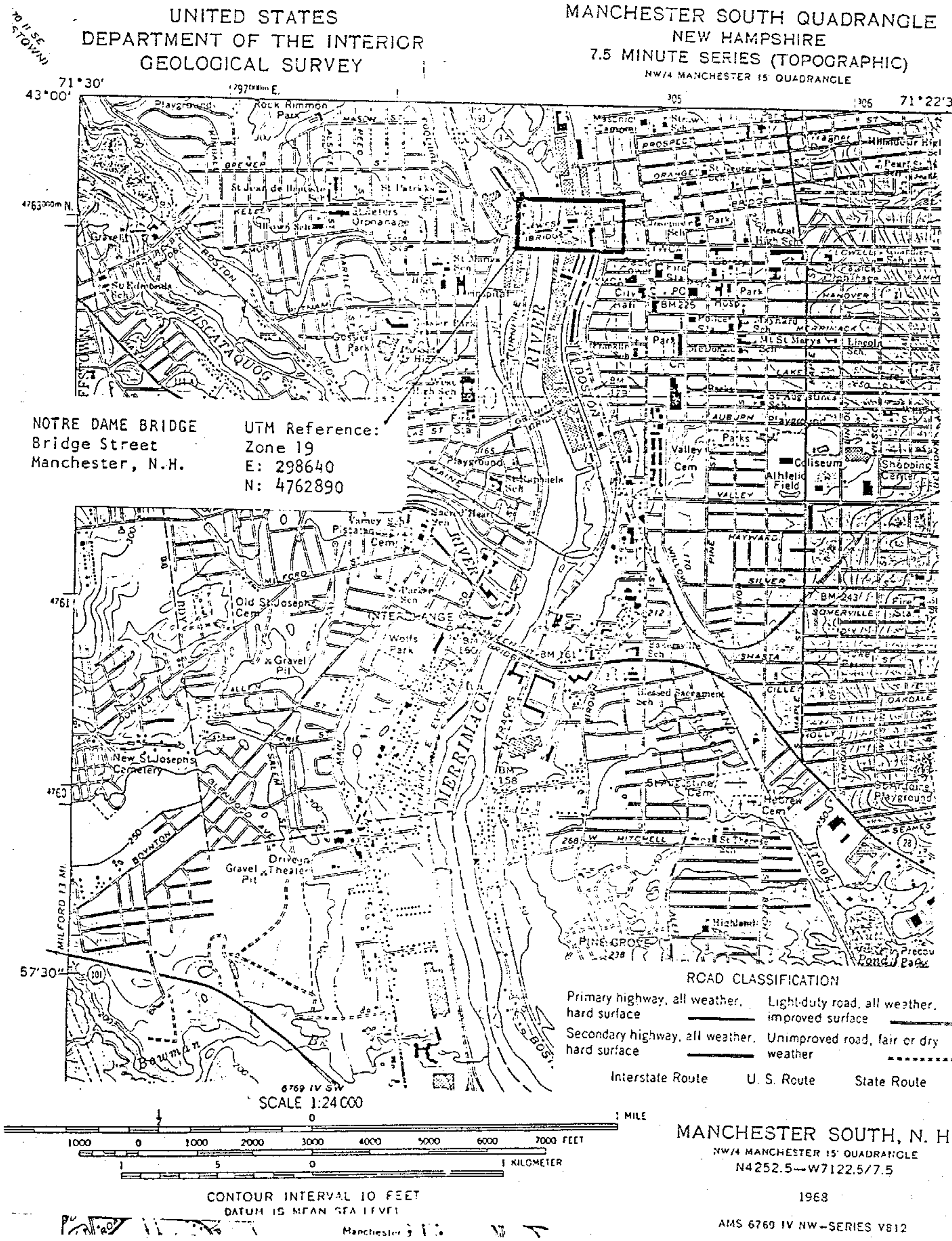
Photographic print of Notre Dame Bridge. Ernest Gould, Hooksett, NH, photographer, 1987. Notre Dame Bridge vertical file. Manchester Historic Association. Manchester, NH. (Photograph NH-14-3)

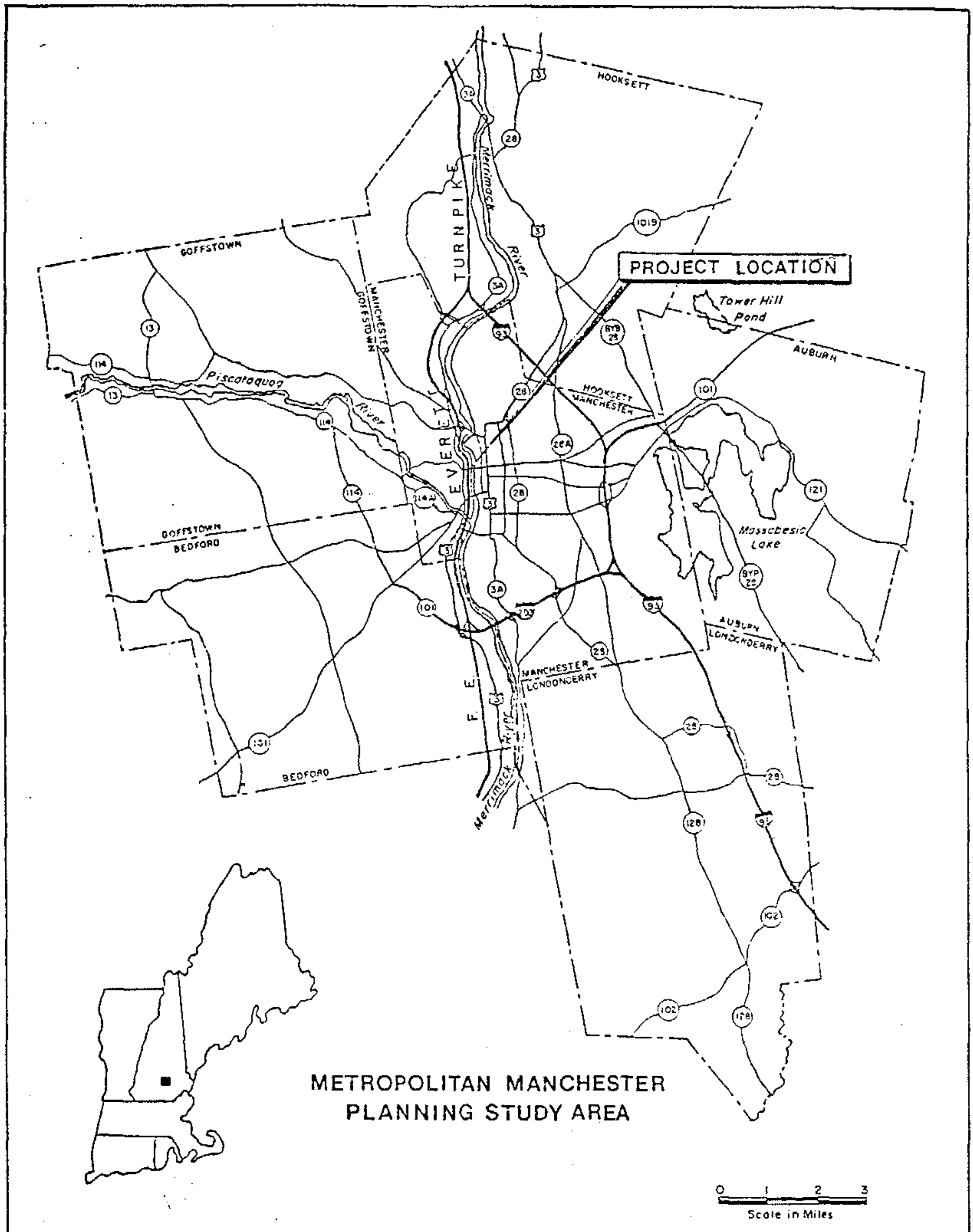
Original Engineering Drawings

Blueprints for Proposed New McGregor Bridge by J. R. Worcester & Company, Engineers, Boston, Massachusetts. Contract No. 1 dated September 1936 (3 sheets). Contracts No. 2 (10 sheets), No. 3 (9 sheets), and No. 4 (6 sheets) are dated October 1936. Drawings for Contracts No. 1, 3 and 4 are filed with the City of Manchester, NH Highway Department plan archives. Drawings for Contract No. 2 are filed with the New Hampshire Department of Transportation, Bridge Design Division plan archives, Concord, NH.

Interviews

Roper, Steven J. Historic Bridge Specialist, Massachusetts Department of Public Works, Boston, Massachusetts. Interview with Christopher W. Closs (by telephone), March 16, 1988, regarding background on Joseph R. Worcester, his firm and the number of bridges in Massachusetts attributed to this engineer.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MANCHESTER SOUTH QUADRANGLE
NEW HAMPSHIRE
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 MANCHESTER 15' QUADRANGLE
NOTRE DAME BRIDGE
Bridge Street
Manchester, N.H.
UTM Reference:
Zone 19
E: 298640
N: 4762890
MERRIMACK RIVER
PISCATAQUOG
ROAD CLASSIFICATION
Primary highway, all weather, hard surface
Light-duty road, all weather, improved surface
Secondary highway, all weather, hard surface
Unimproved road, fair or dry weather
Interstate Route
U. S. Route
State Route
SCALE 1:24 000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
MANCHESTER SOUTH, N. H.
NW/4 MANCHESTER 15' QUADRANGLE
N4252.5—W7122.5/7.5
1968
AMS 6769 IV NW—SERIES V812



STATE OF NEW HAMPSHIRE DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	LOCATION PLAN	Figure I-1
Notre Dame Bridge Replacement		

New Hampshire Bridge Inventory Card Index 1940
New Hampshire Department of Transportation

WATERWAY

ELEVATION — AREA BRIDGE OPENING 21,500□' ± ample — AREA RELIEF OPENINGS approach spans.
GRADE CENTER OF BRIDGE 74' ± — MAXIMUM VELOCITY OF FLOW — MAXIMUM RECORDED FLOW — DATE
LOW BRIDGE 68' ± — SKEW OF FLOW (SKETCH) about 12° skew with bridge.
LOW WATER — DRAINAGE AREA (SIZE AND CHARACTER) 1,684,890 acres. Wooded slopes and cultivated intervales.
NORMAL HIGH WATER
MAXIMUM HIGH WATER +52' ± 1936 — DRIFT AND ICE
FREQUENCY AND DURATION OF FLOODS

CHANNEL WIDTH 415.0' — MINIMUM ELEVATION BOTTOM +17.0 ± '
BANKS AND BED

ALIGNMENT

PROTECTION WORKS AND RIPRAP stone retaining walls up & dnstr.

DAMS Dam & power house @ Amoskeag Falls about 0.6 Mile upstr.
REMARKS

SUPPORTING MATERIAL. TYPE Yellow sand, gravel & brick fill.
TEST DATA Wash borings taken at site.

PILES, TYPE — SIZE — LENGTH
REMARKS 4 spans from East abut. to pier 4 was contr. #2 (WPGM-301): 6 east approach spans from pier 4 to pier 10 & 2 west approach spans contr. #3 & River span

PAT. APR.3,'23 FEB.8,'27 96-C-7394-14 Contr. #4 was Manchester PWA-1035 R

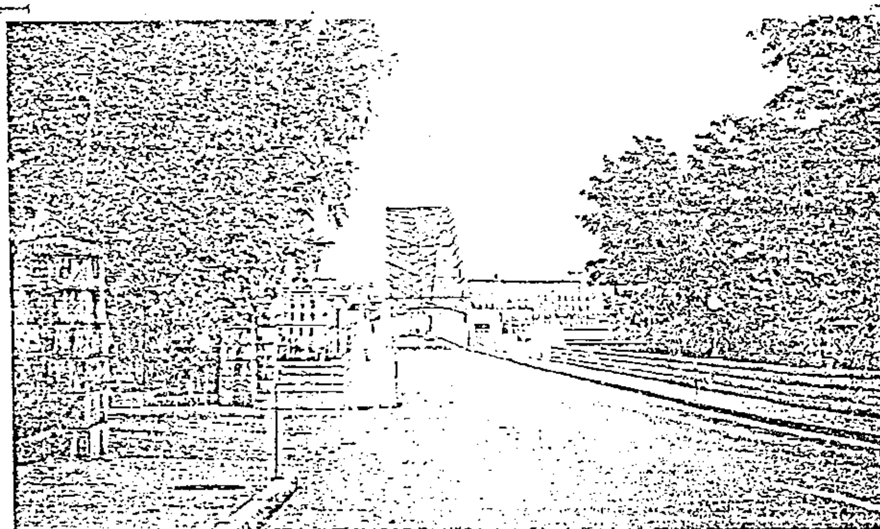
STATE HIGHWAY DEPT. Div. 8 NH — GENERAL CARD — MADE WHP — CARD 1 OF 6
DATE 7/31/40 — (SEE SPAN CARDS FOR DETAILS) — CHECKED

TOWN Manchester — NO. 122/072. — BRIDGE OVER Merrimack R & B+MRR — TOTAL LENGTH 1459-6"
RATING H-15 FOR SPAN — DESIGN LIVE LOAD H-15 — REQUIRED LIVE LOAD — POSTED LIVE LOAD — YEAR BUILT 1936

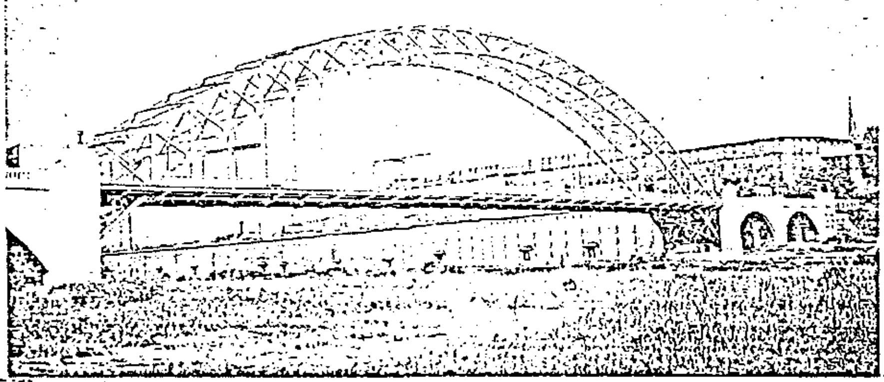
SPANS C.C. Sp. NO.	TYPE	LENGTH	TYPE FLOOR		WIDTH ROADWAY	SIDEWALKS RIGHT	SIDEWALKS LEFT	ALIGNMENT	GRADE PERCENT	SIGHT DISTANCE	GUARD RAIL
4	Conc Arch Rib	64-3"	Conc Slab	BRIDGE	30-0"	6-0	6-0	tan.			
7		81-6"	"	W. REAR APPROACH	30-0"	"	"	"			
1	2 Gird. Frame	80-0"	"	E. FORWARD APPROACH	40-0	10-0	10-0	"	+4.75%		
1	Cont. Truss Arch	430-0"	Open Grid								
				BRIDGE SKEW —	MINIMUM VERTICAL CLEARANCE 14-1"				FOR SPAN River span		

APPROACH PAVEMENT (WIDTH AND TYPE)
DESIGNED BY J.R. Worcester Co., Boston. — BUILT BY N.H. State & City of Manchester
MAINTAINED BY Manchester City. — PLANS on file for 4 east approach spans 1-10-4-1
PROJECT NO. WPGM 301 (over R.R.) PWA 1035 R — CONTRACTOR — ~~TOLL OR~~ FREE
FABRICATOR Boston Bridge Works (Railroad span).
TOTAL COST — STRUCTURE COST — APPROACH COST
LIGHTING SYSTEM Elec luminaire on spun conc shafts each pylon 16 each side
BENCH MARK DATA from City datum El. 0.00

TRAFFIC SURVEY DATA A B C D F G H I
REMARKS
SUBSTRUCTURE
ABUTMENTS Mass conc.
PIERS OR BENTS 17 bents mass conc.
REMARKS
Macgregor Bridge.
1.7 Miles East from Manchester-Goffstown T.L. to center of river span.



West approach looking toward Elm St. in City



Upstream side River span + West approach

TOWN	BRIDGE NO.	ROUTE	STRENGTH	CLEAR ROADWAY	VERTICAL CLEARANCE
Manchester	122/072	NH 114		29-32+	14'

SUBSTRUCTURE

ABUTMENTS

PIERS OR BENTS mass conc.

REMARKS

SUPPORTING MATERIAL TYPE

TEST DATA wash borings taken @ site.

PILES TYPE SIZE LENGTH

REMARKS This portion of bridge constructed under Contract #7 - Grade Crossing Project WPGM-301 and includes 1 approach span on East + 2 approach spans on west (Reinconc Arch Rib spans)

LEGAL HISTORY

Kalindex PAT. APR. 3, '23 FEB. 8, '27 86-C-7397-14

STATE HIGHWAY DEPT. Div 8 RAILROAD GRADE SEPARATION MADE WHP CARD 2 OF 4

DATE 7/31/40 NH (SEE SPAN CARDS FOR DETAILS) CHECKED HCS

TOWN Manchester NO. 122/072 RAILROAD B & M Southern Div TOTAL LENGTH 94.6 conc flo...

RATING H-15 FOR SPAN DESIGN LIVE LOAD H-15 REQUIRED LIVE LOAD POSTED LIVE LOAD YEAR BUILT 1936

TYPE SEPARATION Highway over Railroad NO. TRACKS 2 TRACK SKEW

GENERAL	WIDTH ROADWAY	WALKS RIGHT	WALKS LEFT	ALIGNMENT	GRADE PERCENT	SIGHT DISTANCE	CLEARANCE HORIZONTAL	CLEARANCE VERTICAL	SPANS NO.	SPANS TYPE	SPANS LENGTH	SPANS TYPE FLOOR
BRIDGE	30-0	6-0	6-0	tan	8/16 camber		41-9	open	1	R Gird Frame	82-0 eff	conc s...
REAR APPROACH												
FORWARD APPROACH	40-0	10-0	10-0		+4.787							
RAILROAD							10-0	18-9				
							limit W. Track					

APPROACH PAVEMENT by City of Manchester East approach Granite block paving

APPROACH GUARD RAILS

DESIGNED BY J. R. Worcester Co. Boston BUILT BY NHHD

MAINTAINED BY City of Manchester PLANS on file 1-10-1-1

PROJECT NO. WPGM-301 CONTRACTOR

FABRICATOR Boston Bridge Works

TOTAL COST STRUCTURE COST APPROACH COST

APPORTIONMENT OF COST

PROVISION FOR RAILROAD DEVELOPMENT

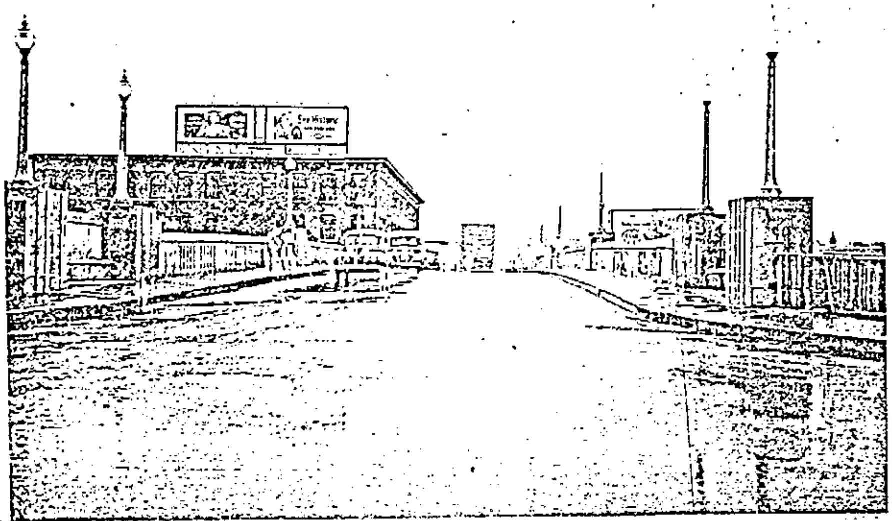
DRAINAGE Thru exp jts into drains provided LIGHTING SYSTEM Elec Std on each pylon

BLAST PROTECTION C. I. B's secured to struct steel COLLISION PROTECTION

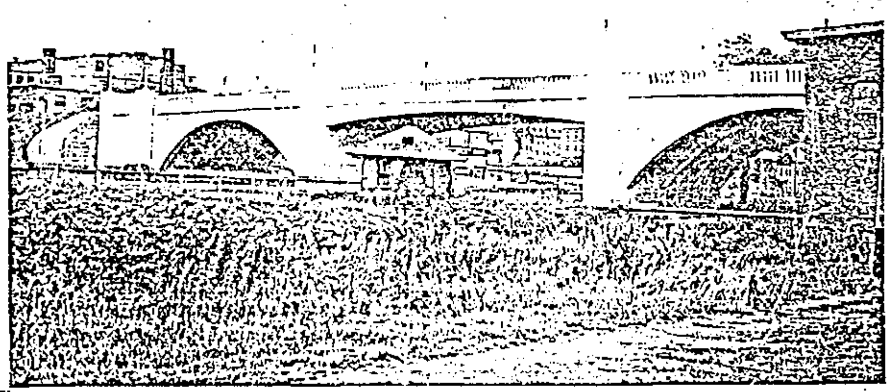
TRAFFIC SURVEY DATA A B C D F G H

RAILROAD TRAFFIC Main line passenger + freight Boston-Concord North + South boun...

Span #2 between Piers #1 + 2 Macgregor Bridge



East approach looking toward West Side



North side east approach

TOWN	BRIDGE NO.	ROUTE	STRENGTH	CLEAR ROADWAY	VERTICAL CLEARANCE
Manchester	122/072	NH 114			

STATE HIGHWAY DEPT. Div. 8 NH — STEEL SPANS — MADE W.H.P. — CHECKED — CARD 3 OF 6

DATE 1/31/40

TOWN Manchester NO. 122/072 BRIDGE OVER B & M. Railroad SPAN NO. RR span #2

RATING H-15 MEMBER DESIGN LIVE LOAD H-15 REQUIRED LIVE LOAD POSTED LIVE LOAD YEAR BUILT 1936

NO. AND TYPE SPANS 1 - Plate Girder Rigid Frame TOTAL LENGTH 94-6 conc floor

SKEW — SUPERELEVATION CROWN APPROACH PAVEMENT

GENERAL	ALIGNMENT	GRADE	SIGHT DISTANCE	SPAN LENGTH		WIDTH		CLEARANCE	ROADWAY	RAILROAD	HIGH WATER
BRIDGE	tan. 2' camber			C. C. BEARINGS	82-0	BETWEEN CURBS	30-0				
REAR APPROACH	"	+4.787		O. O. FLOOR	94-6	BETWEEN RAILS	42-0	HORIZONTAL	41-9	10-0	
FORWARD APPROACH				CLEAR SPAN	80-0	WALKS B. S.	6-0	VERTICAL	open	18-9	

DESIGNED BY ~~HIGHWAY DEPT.~~ CONS. ENG. J. R. Worcester Co. BUILT BY NHHD

MAINTAINED BY ~~STATE~~ TOWN ~~RAILROAD~~ PLANS ON FILE ~~NOT ON FILE~~ ~~TOLL OR~~ FREE

PROJECT NO. WPGM-301 CONTRACTOR

TOTAL COST STEEL COST FLOOR SLAB COST

TRAFFIC SURVEY DATA A B C D E F G H

WATERWAY. ELEVATION LOW BRIDGE ELEVATION MAXIMUM HIGH WATER AREA BRIDGE OPENING

ALIGNMENT AND CHARACTER CHANNEL

REMARKS

SUBSTRUCTURE	MATERIAL	TYPE	HEIGHT	SUPPORTING MATERIAL	PILES—TYPE	NO.	SIZE	LENGTH	CAPS
REAR ABUTMENT									
FORWARD ABUTMENT									
PIERS OR BENTS	Conc	mass							
WINGS									

REMARKS

Poliplex PAT. APR. 3, '23 FEB. 8, '27 96-C-7396-14

SUPERSTRUCTURE. MATERIAL Struct Steel + Conc SPAN TYPE Plate Girder Rigid Frame*

GRADE TO BRIDGE SEAT GRADE TO LOW STEEL 3-1 @ crown (To low Conc @ crown - 3'-5")

DEPTH PANELS AT PAINT none required as all steel is incased

	WEARING COURSE	FLOOR	CURBS	ROAD RAIL	WALK RAIL	BEARINGS EXPANSION	BEARINGS FIXED
MATERIAL	Asphalt	Rein Conc	Conc		Rein Conc		
TYPE	Pre-mix	Flat Slab	-		Open	no exp device required	
HEIGHT			0-10"		3-9	Masonry Brg plates	
THICKNESS	0-2"	0-6½"		1-10"	1-0" wide	14 x 1 x 1-3"	
FASTENINGS		—				2 A bolts 1½ x 1-5	

FLOOR DRAINAGE Thru exp jts in floor into gutter + 6" C.I. Pipe drains in conc pier below

REMARKS

3'-6 b.b fl @ crown 6'-4⅝"

* Plate Girder Frame arch effect 2-6 b.b flg Ls @ crown, 5-4⅝" b.b @ pier

Legs 5-9½ b.b @ top, 1-1 @ bottom 19-9 high (Ext Girders 1-0" deeper.)

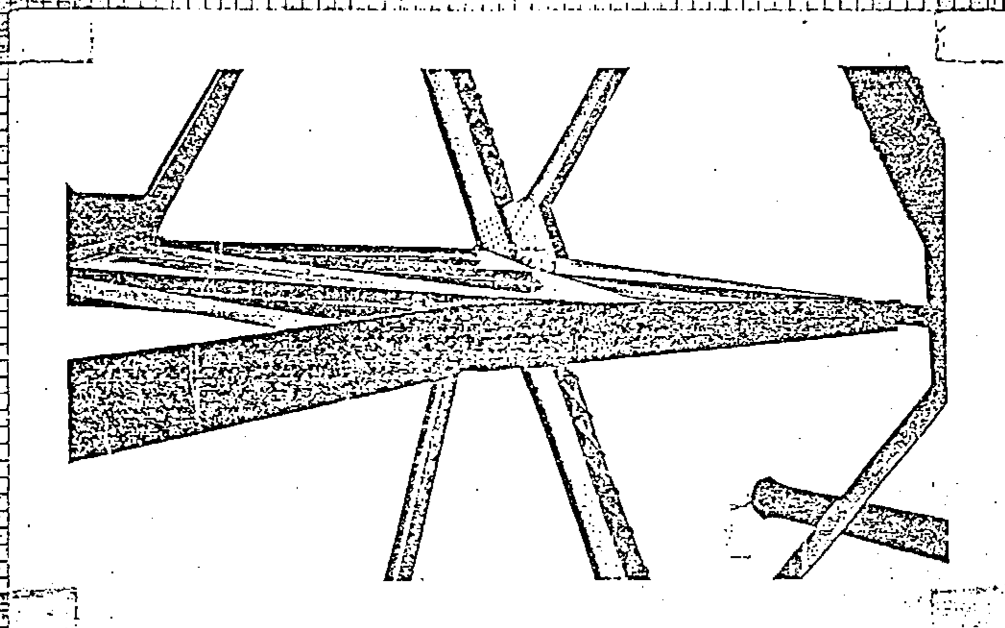
Web Pl 3/8" Flanges 2 Ls 6x6x⅝" except 2 Ls 6x4x½" for Ext. Gird.

Transverse floor bms 12" I 31.8 @ 8-0 c.c for Rdwy: 10" I 25.4 for S. W.

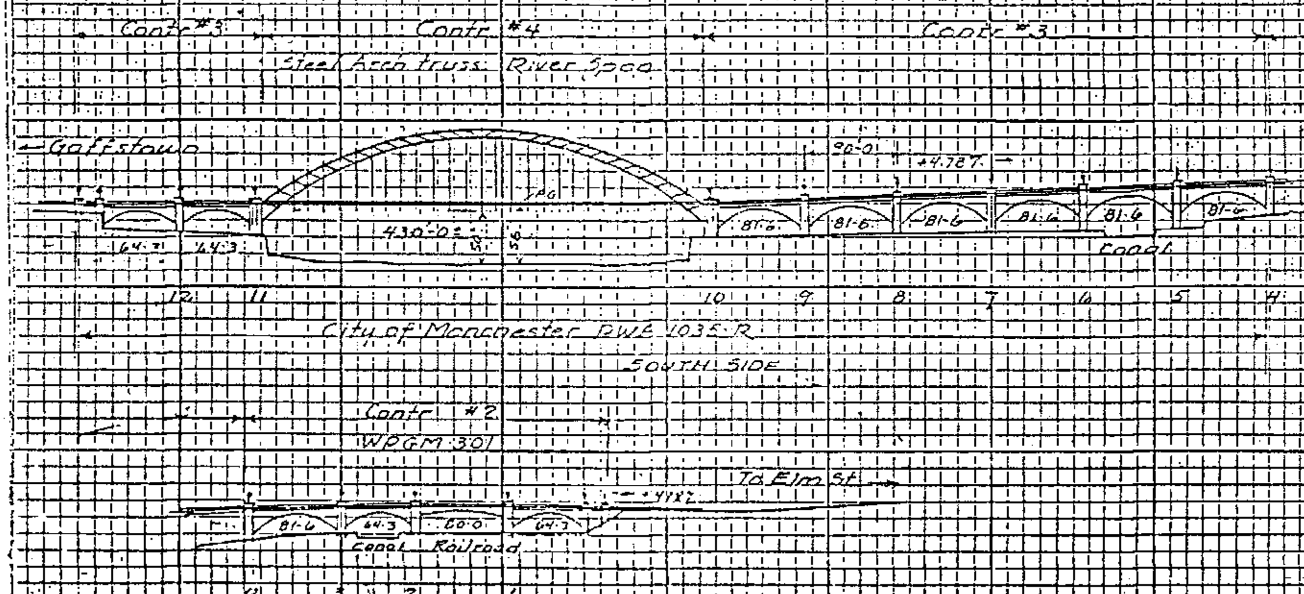
Ext Girder + legs of all girders incased with conc. Int girders + transverse bms incased with 2" Gunite

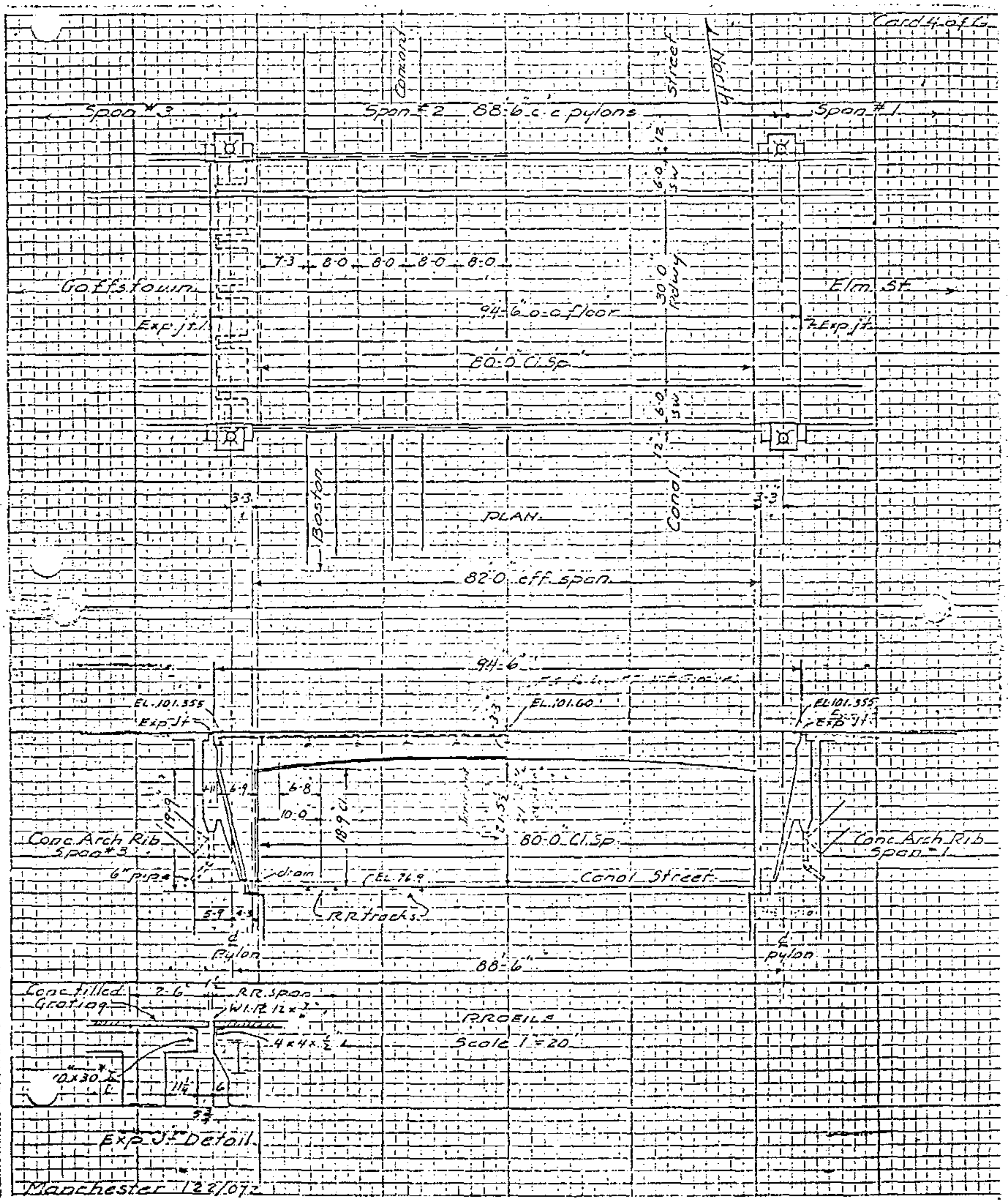
Span #2 between piers #1 + #2 Macgregor Bridge

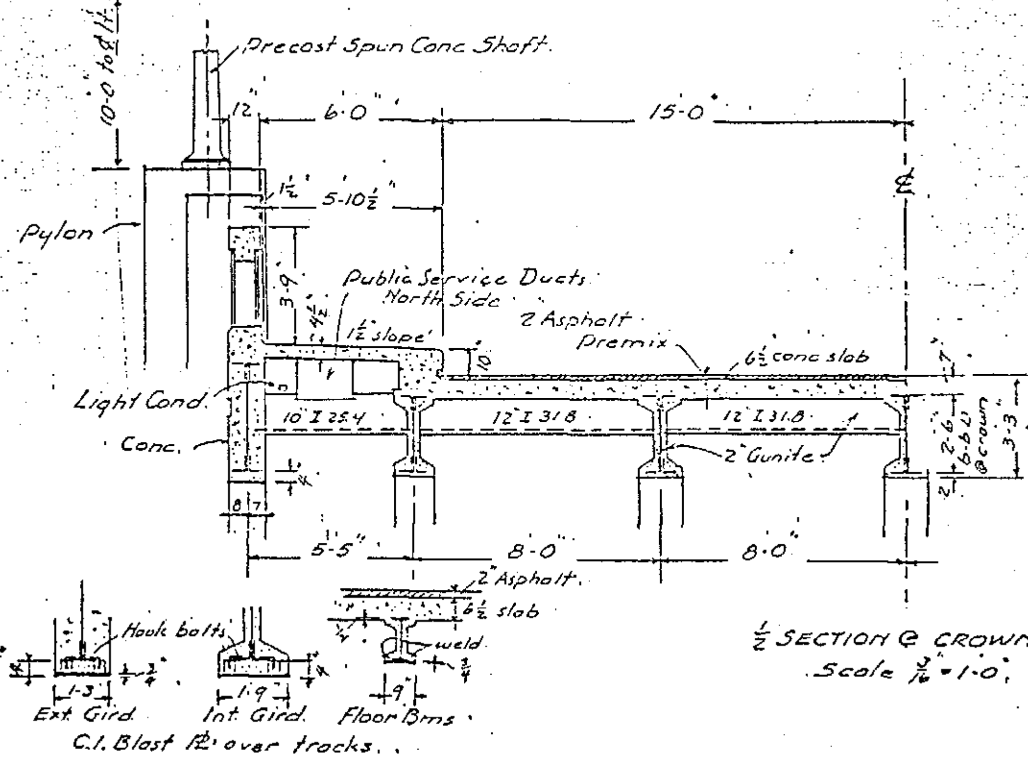
TOWN	BRIDGE NO.	ROUTE	STRENGTH	CLEAR ROADWAY	VERTICAL CLEARANCE
Manchester	122/072	NH 114			



Bent steel on West End River Span




Card 4 of 6
Span #3
Span #2 88'-6" c.c. pylons
Span #1
North
Canal
Street
Goffstown
Elm St.
Exp. jt.
94'-6" o.o. floor
80'-0" Cl. Sp.
30'-0" Rdwy
Boston
Canal
PLAN
82'-0" eff. span
94'-6"
EL. 101.355
EL. 101.60
Conc. Arch Rib Span #3
Conc. Arch Rib Span 1
80'-0" Cl. Sp.
Canal Street
RR tracks
EL. 76.9
Pylon
88'-6"
PROFILE
Scale 1" = 20'
Conc. filled Grating
R.R. span
Exp. Jt. Detail
Manchester 122/072



½ SECTION @ CROWN
Scale 3/16" = 1'-0"

DATE 7/31/40 STATE HIGHWAY DEPT. Div. 8. 114 CONCRETE & MASONRY SPANS MADE WHP CHECKED CARD 5 OF 6

TOWN Manchester NO. 122/072 BRIDGE OVER Merrimack River (approach) SPAN NO. 5 Typical

RATING H-15 MEMBER DESIGN LIVE LOAD H-15 REQUIRED LIVE LOAD POSTED LIVE LOAD YEAR BUILT 1936

NO. AND TYPE SPANS Rein Conc Arch Rib. TOTAL LENGTH 90-0 c-c pylons

SKEW — SUPERELEVATION CROWN APPROACH PAVEMENT

GENERAL	ALIGNMENT	GRADE	SIGHT DISTANCE	SPAN LENGTH		WIDTH		CLEARANCE	ROAD-WAY	RAIL-ROAD	HIGH WATER
BRIDGE	tan			C. C. BEARINGS		BETWEEN CURBS	30-0				
W REAR APPROACH	"			FLOOR	89-10½	BETWEEN RAILS	42-0	HORIZONTAL	41-9		
E FORWARD APPROACH	"	-4.787		CLEAR SPAN	81-6	WALKS B S	6-0	VERTICAL	open		

DESIGNED BY J. R. Worcester Co. BUILT BY City of Manchester + NHHD.

MAINTAINED BY City PLANS on file 1-10-1-1 ~~TOLL OR~~ FREE

PROJECT NO. PWA 1035 R CONTRACTOR

TOTAL COST CONTRACT PRICE

TRAFFIC SURVEY DATA A B C D F G H

WATERWAY. ELEVATION LOW BRIDGE ELEVATION MAXIMUM HIGH WATER AREA BRIDGE OPENING

ALIGNMENT AND CHARACTER OF CHANNEL

REMARKS

SUBSTRUCTURE	MATERIAL	TYPE	HEIGHT	SUPPORTING MATERIAL	PILES—TYPE	NO.	SIZE	LENGTH	CAPS
REAR ABUTMENT									
FORWARD ABUTMENT									
PIERS OR BENTS	Conc	mass							

WINGS

REMARKS

Tabindex PAT. APR. 3, '23 FEB. 8, '27 96-C-7390-14

SUPERSTRUCTURE. MATERIAL: (AVERAGE COMPRESSIVE STRENGTH FROM CONSTRUCTION TESTS) Conc Cl A.

SPAN TYPE Conc Arch Rib LENGTH C. C. BEARINGS

GRADE TO BRIDGE SEAT GRADE TO LOW BRIDGE 3-8¾ @ crown

	WEARING COURSE	CURBS	ROAD RAIL	WALK RAIL	EXPANSION JOINTS
MATERIAL	Asphalt	Rein Conc		Rein Conc	
TYPE	Pre-mix	0-10"		Open type	
HEIGHT	0-2"			3-9"	

REMARKS Rein Conc Pylons + spandrel walls in superstructure.

SLAB SPANS AND RIGID FRAMES

	CENTER	ENDS	LEGS TOP	LEGS-BOTTOM	JOINT-LEG TO FOOTING (RIGID OR HINGED)
THICKNESS					RATIO LEG TO SPAN
					REMARKS

T BEAMS AND RIBBED RIGID FRAMES

NO.	SPACING	BEAMS WIDTH	BEAMS DEPTH CENTER	BEAMS DEPTH ENDS	LEGS THICKNESS NORMAL TO SPAN	LEGS WIDTH TOP	LEGS WIDTH BOTTOM	HEIGHT	SLAB THICKNESS
									BEARINGS
									JOINT-LEG TO FOOTING (RIGID OR HINGED)

REMARKS

Span #5 between Piers 4 + 5 (Typical). Macgregor Bridge (over)

TOWN	BRIDGE NO.	ROUTE	STRENGTH	CLEAR ROADWAY	VERTICAL CLEARANCE
Manchester	122/072	NH 114	-H5, H6, H8, H10, H12, H15, H20	14-16, 18-22, 24-26, 26-32+	-10, 11, 12, 13, 14, 14+, OC

GIRDERS

NO.	SPACING	WIDTH	DEPTH CENTER	DEPTH ENDS	SLAB THICKNESS

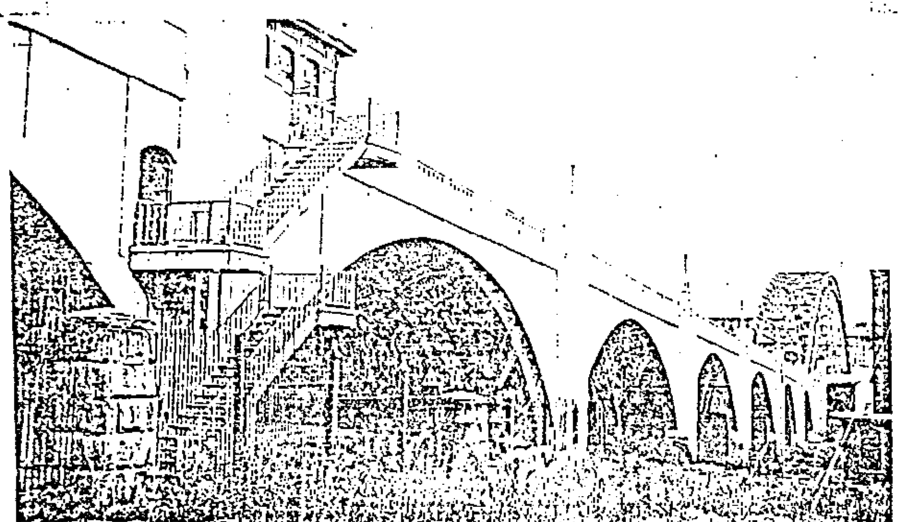
	NO.	SPACING	TYPE	WIDTH	DEPTH
FLOORBEAMS	9	9-0 c.c	Rein Conc	1-4	Varie
STRINGERS					
BEARINGS					

REMARKS

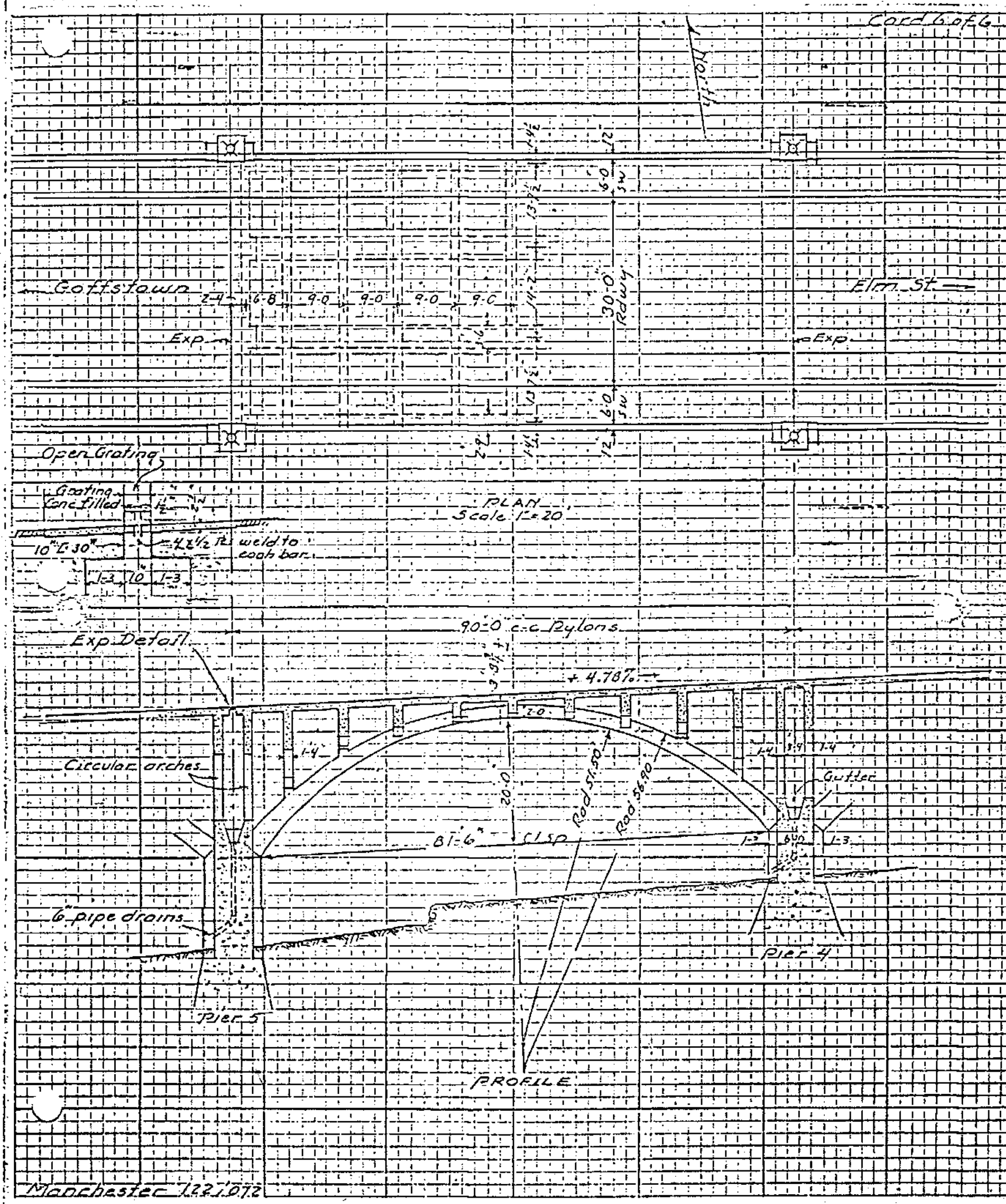
ARCHES. MATERIAL Rein Conc CLEAR SPAN 81-6" RISE 20-0"
TYPE Arch Rib SHAPE circular

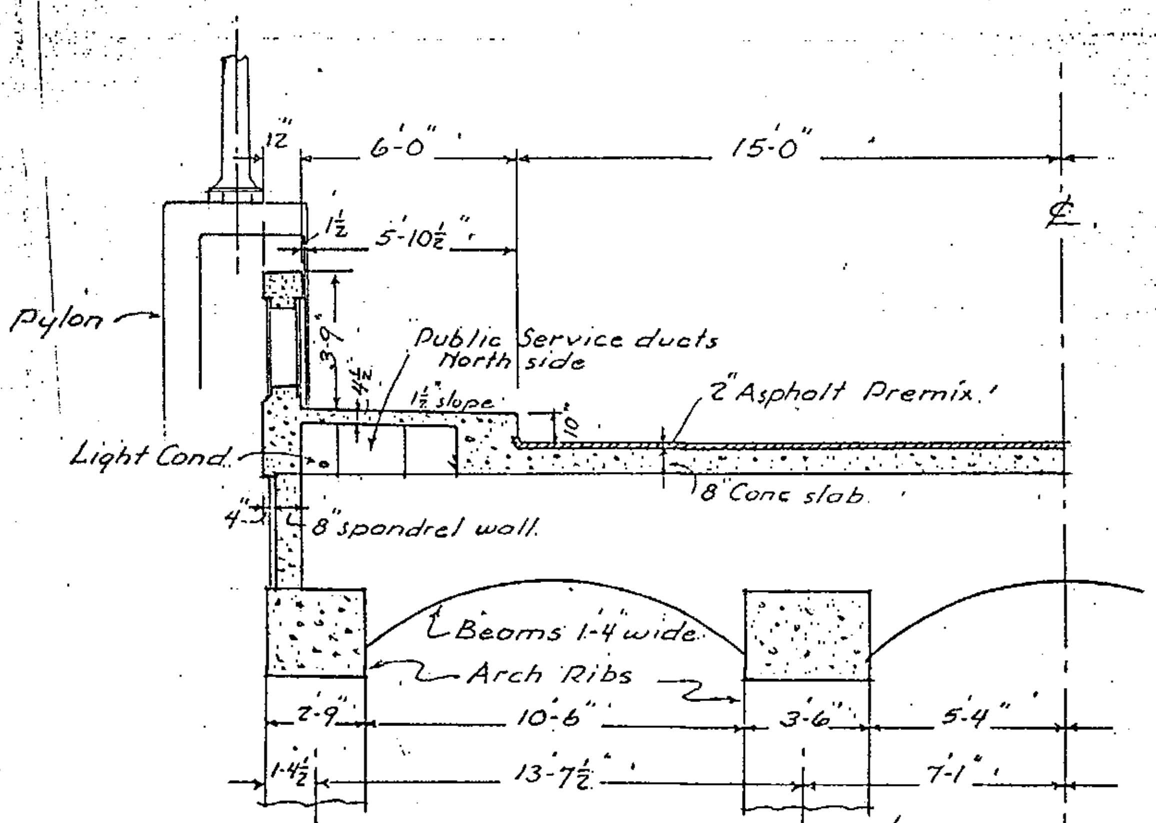
RIBS NO.	RIBS SPACING	RIBS WIDTH	THICKNESS CROWN	THICKNESS SPRING	THICKNESS DECK SLAB	REMARKS
2	14-2 c.c	3-6	2-0	3-3	0-8	
2	13-7½	2-9	"	"	"	

Conc Arch Rib spans
2 spans 64-3 Cl span (1 each side RR overpass) } East end WPGM-301
1 " 81-6 } Contr # 2
6 " 81-6 " East approach } City of Manchester PWA 1035 R
2 " 64-3 " West " } Contr # 3



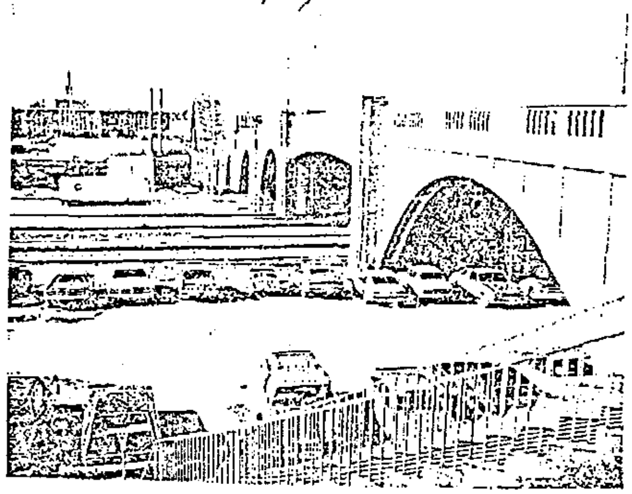
Upstream side East approach


Card 6 of 6
Goffstown
Elm St
Exp
2-4
6-8
9-0
9-0
9-0
9-C
30-0
Rdwy
6-0
SW
12
Open Grating
Grating
Conc filled
10" [30"
weld to each bar
1-3
10
1-3
PLAN
Scale 1"=20'
Exp Detail
90-0 c-c Pylons
+ 4.78%
Circular arches
1-4
20-0
Rod 51.50
Rod 56.90
81-6"
Cl Sp
Gutter
1-3
1-3
6-0
1-4
3-9
1-4
6" pipe drains
Pier 5
Pier 4
PROFILE
Manchester 122.072



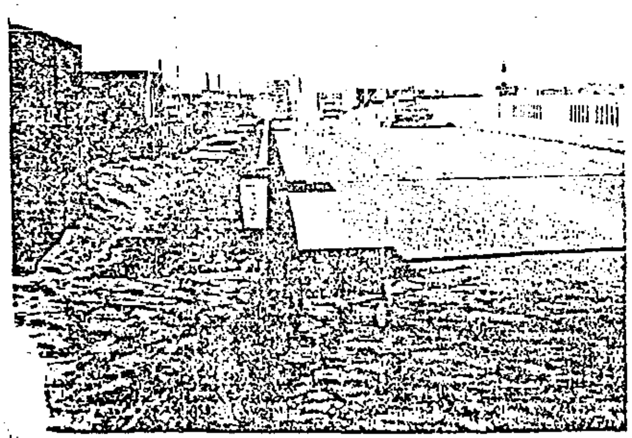
½ TYPICAL SECTION
Scale $\frac{3}{16}" = 1'-0"$

Top



South Elevation

Top



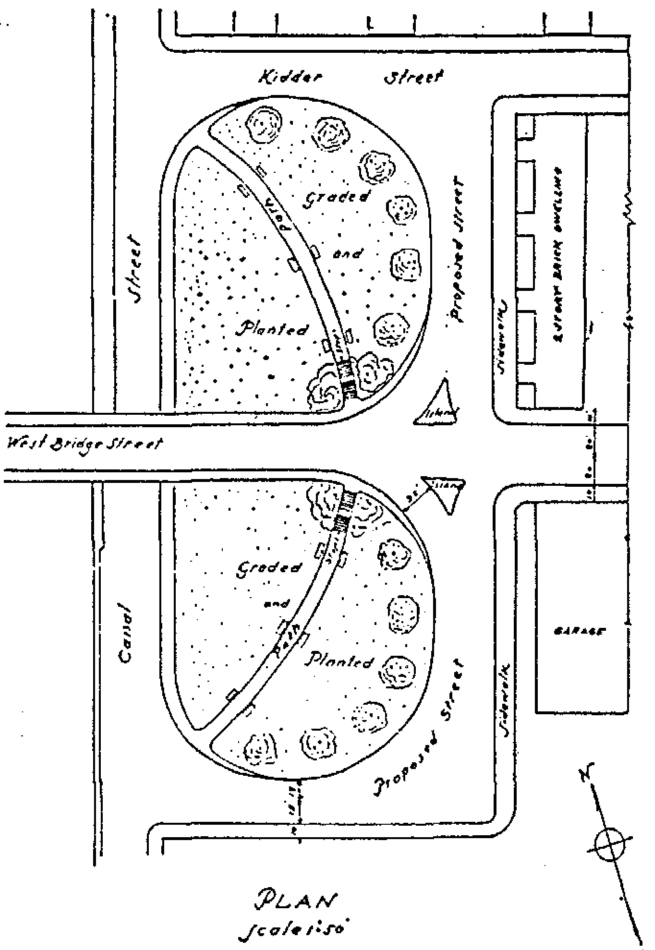
East Approach

Manchester Br. #122/072

Schematic Plan for New Approach
to McGregor Bridge (East Side)

Union Leader. (Manchester, N.H.)
(undated - c. 1936)
Manchester Historic Association
Manchester, N.H.
Notre Dame Bridge vertical file

New Bridge Approach



Plans for the east approach to the new McGregor bridge have been completed and the above is a tracing from the blueprints. Three streets will lead to the bridge. There will be West Bridge and two from Canal street, one by way of Kidder street and the other through a proposed new street south of the span. The plans indicate that a small park will be made at the approach with trees and grass planted. A path will be built across the center of the park on both sides of the bridge. Five tenement buildings of the Amoskeag were bought by the city and are being torn down to make this approach to the bridge a possibility.